Fireballs

IN addition to the occurrences recently recorded in your columns, it may be well to quote a further observation communicated in a letter, by Lady Borthwick, to the *Morning Post* for August 16, dated from Derculich, Ballinlaig, Perthshire, from which I extract the following particulars:—

As several curious phenomena of a like kind had been described as having occurred in Edinburgh during a terrific thunderstorm on Tuesday, August 12, the writer proceeds to detail what had been witnessed by herself and some others in her neighbourhood. The storm began at 10 o'clock in the morning and continued with unabated violence till past 10 at night. It appeared to be at its height from about 3 till 7 p.m., when as many as three flashes of lightning occurred to one peal of thunder. In many cases they were of a vivid pink colour. At about 6 o'clock a loud noise was heard, unlike any preceding it: "the heavens seemed to open, and there issued from the clouds what appeared like a ball of fire, about the size of a man's head, which exploded with a terrific crash, emitting quantities of sparks." It then appeared to descend at a distance of not more than twenty yards from the house. Mr. J. K. Laughton, commenting upon the phenomenon in the next issue, states that "ball lightning" is not solid, but yet in "passing along the surface of soft land it ploughs it up in a way that no cannon ball could do," and refers to an instance of this mentioned by Scott in his "Elementary Meteorology."

At a recent meeting of the Paris Academy of Sciences, M. Gaston Planté illustrated some remarks upon globular electric bolts by producing artificially effects analogous to those of fireballs, and it would be interesting to know more respecting their nature. As they appear to occur only very occasionally, on account of the rare conditions of the atmosphere producing them, it is certainly advisable to collect all the evidence respecting them that is obtainable. By such means it may in the course of time become possible for those who are competent to deal with the facts, to arrive at some definite conclusions concerning this little understood phenomenon. WM. WHITE

September 2

Deep-Sea Corals

PROF. H. N. MOSELEY, F.R.S., in his masterly address to the Biological Section of the British Association at Montreal, dealt, amongst other matters, with the zoological position of the remarkable genera of deep-sea corals named *Guynia*, *nobis*, and *Haplophyllia* and *Duncania*, of Pourtalès. He states that he has found, after examing sections of the last-named genus, that the soft parts indicate that it and the others are *Hexactinia*, and have the construction of *Caryophyllia* and of all other corals of that group. These genera were placed amongst the Rugosa, the first-mentioned by myself fourteen years since, and the others by Pourtalès later on. On April 3 of the present year I read a communication to the Linnean Society, entitled "A Revision of the Families and Genera of the Madreporaria," and this revision is published. As Prof. Moseley left England before I could send him a copy, he and some other naturalists who study the corals will be perhaps interested by knowing that I have placed those genera where Prof. Moseley has located them subsequently. They form an alliance in the family Turbinolidæ, and I was led to alter the classificatory position on account of a careful examination of the hard parts.

August 30 P. MARTIN DUNCAN

Iridescent Lunar Halos

ON the evening of July 4, from 5.30 p.m. to 7 p.m., the moon, eleven days old, was surrounded with a series of extraordinary halos consisting of a succession of concentric rings; fine, clear starlight; very light airs from south-west and west-south-west; thermometer, 42°.

At 5.30, very light fleecy scud from south-west, the moon surrounded with a halo of about three times its diameter, of dullish white within a ring of orange; rapid changes ensued: the moon appeared within an opaque circle intensely white, surrounded with chromatic rings in the following order—yellow, orange, red, indigo, a broad ring of blue, yellow, orange, red, indigo, deep blue, bordered by a faint ring of orange. At this time the moon appeared as a bright boss on a many-coloured shield; changes rapidly followed: at 5.35 the rings were as follows—white, yellow, orange, red, indigo, blue, yellow, orange; for some moments the outer ring of orange became blurred, the broad ring of blue very deep and beautiful; at 5.50 all of the halo had disappeared; sky clear, bright starlight all round, except where a few light fleecy clouds lay to the north-east. At 6.10 light scud from south-west; at 6.12 halo again formed, as follows—white, yellow, orange; in a few moments were added red, indigo, blue, orange; soon a mass of whitish scud, light and fleecy, seemed to gather round the moon widely, in a huge irregular oval, changing almost to a circle with uneven edges. At 6.20 the halo had disappeared; then came a bow-shaped yellowish coloration on the south-west of the moon, changing instantly to orange, red, indigo, faint indistinct orange; at 6.22 all clear again; at 6.29 bright almost dazzling rays immediately surrounded or jettied from the moon. At 6.30, north of the moon, orange appeared on some light scud; soon changes again took place: immediately on the edge the moon, where the rays were so brilliant, was now very dark with jagged edges within an intensely white ring, surrounded with a series of sharply-defined chromatic rings in the order they appeared at 5.35. At 6.35 another mass of whitish scud widely surrounded the moon as before described; at 6.48 all clear again; instantly after an orange patch appeared on scud to the north; at 6.56 orange on east; at 7 p.m. all was again clear; rays as dazzling as at an earlier period; temperature sensibly lower; frost at night. T. H. POTTS

Ohinitahi, N.Z., July 5

Sextants

IN your review of the "Encyclopædia Britannia" published last week I notice that reference is made to an article on navigation by Capt. Moriarty, and attention is called to the very serious error in sextants arising from false centering. Having had some experience in the examination of these instruments, I can practically testify to this most important defect. Only a week or so since two sextants were received here for trial, one of which belonged to a captain of the mercantile marine. In both instances, although the mirrors and shades were good, yet the arc error due to false centering was excessively large, increasing from 0 at 0° to + 7′ at 60°, while at 90° it amounted to 10′. Surely this must be a serious matter to navigators, but, as you point out, for the small fee of five shillings persons ordering a sextant may direct the maker to send it to the Observatory, where suitable apparatus is arranged not only for examining the arc but also the mirrors and shades. It is only fair, however, to say that when instruments are sent direct from the makers we do not often have occasion to reject one. Indeed, superior sextants by first-class makers rarely have an error exceeding 1′ of arc, and often not more than 30″, but how few these are in comparison with the hundreds of inferior instruments that pass into the hands of the public without being tested. T. W. BAKER

The Kew Observatory, Richmond, September 2

Electrical Rainbow

I WAS one of a deputation of River Tyne Commissioners who visited the South Foreland, to see the experimental lights now on trial there, on Saturday night, August 30. We were walking across the fields from the lights towards the observing hut No. 2, a distance of about a mile and a half. There was a fog more or less, and a shower of rain as we were approaching the hut, and every time the electric light from A tower revolved, a rainbow, very like a faint lunar bow, made its appearance. I could not see any prismatic colour, and the bow was only produced by the large electric light, with carbons of $1\frac{1}{4}$ inch in diameter. There was no bow visible from the old light, which has carbons of about $\frac{5}{8}$ inch square, and none from either the gas or oil lights. I was informed that this was the first time such a phenomenon had been observed. R. S. NEWALL

Ferndene, September 3

Rainbow on Spray

A CURIOUS appearance, which I have never observed before, was visible here for a few minutes this forenoon. Large breakers were rolling in to the bay, and their fronts (covered with foam) were brilliantly white in the sunshine. But, as each passed a particular spot, directly opposite to the sun, the spray blown back from its crest took a bright reddish-brown colour. *This was the apex of the primary rainbow.* When observed from a

more elevated point, the apparent colour of the spray became bluish. G. H.

September 5

Circular Rainbow seen from a Hill-top

NOTICING a communication in NATURE (p. 361) regarding the phenomenon of a circular rainbow, I thought it worth while to mention a case which lately came under my observation. Standing on a point of rock just opposite the beautiful falls of Montmorenci, Quebec, I was surprised to see a rainbow in the form of a circle passing through my feet. The spray from the falls was being blown into a deep cove in front of me, and the sun was high in the heavens behind. The primary was well defined and very beautiful; the secondary was faint. I understand that the conditions for seeing this circular rainbow are not often favourable at Montmorenci; still it may not be amiss to advise intending visitors *not* to stop at the bottom of the steps which lead down below the falls, but to clamber over the rocks as near the water as possible. W. L. GOODWIN

Montreal, August 28

Intelligence in Frogs

A FRIEND in Scotland has a small lake in his grounds, which are surrounded by a high wall. At the bottom of the lake is a sluice by which the water can be let off into a burn below the grounds. A few weeks ago the lady of the house was walking down the road outside the wall towards the burn when, to her astonishment, she met a multitude of frogs making their way up the road, which makes a considerable detour, to the gate leading into the grounds. On inquiry she found that the lake had that morning been emptied through the sluice, and it was plain that these were frogs which, having been carried down with the water to the burn, were now making their way back to their old home. By what instinct did they know that the long road led to the point from which the short one had started? B. W. S.

September 3

THE TEMPERATURE OF THE SOLAR SURFACE

THE power developed by the sun motor, recorded in NATURE, vol. xxix. p. 217, has established relations between diffusion and energy of solar radiation which prove that the temperature of the surface of the sun is extremely high. I have, therefore, during the summer solstice of 1884, carried out an experimental investigation for the purpose of demonstrating the temperature of the solar surface corresponding with the temperature transmitted to the sun motor. Referring to the illustrations previously published, it will be seen that the cylindrical heater of the sun motor, constructed solely for the purpose of generating steam or expanding air, is not well adapted for an exact determination of the amount of surface exposed to the action of the reflected solar rays. It will be perceived on inspection that only part of the bottom of the cylindrical heater of the motor is acted upon by the reflected rays, and that their density diminishes *gradually* towards the sides of the vessel; also that owing to the imperfections of the surface of the reflecting plates the exact course of the terminal rays cannot be defined. Consequently, the most important point in the investigation, namely, the area acted upon by the reflected radiant heat, cannot be accurately determined. I have accordingly constructed an instrument of large dimensions, a polygonal reflector (see Fig. 1), composed of a series of inclined mirrors, and provided with a central heater of conical form, acted upon by the reflected radiation in such a manner that each point of its surface receives an equal amount of radiant heat in a given time. The said reflector is contained within two regular polygonal planes twelve inches apart, each having ninety-six sides, the perimeter of the upper plane corresponding with a circle of eight feet diameter, that of the lower plane being six feet. The corresponding sides of these planes are connected by flat taper mirrors composed of thin glass silvered on the outside. When the reflector faces the sun at right angles, each mirror intercepts a pencil of rays of 32·61 square inches section, hence the entire reflecting surface receives the radiant heat of an annular sunbeam of $32{\cdot}61 \times 96 = 3130$ square inches section. It should be observed that the area thus stated is 0·011 less than the total foreshortened superficies of the ninety-six mirrors if sufficiently wide to come in perfect contact at the vertices. Fig. 2 represents a transverse section of the instrument as it appears when facing the sun; the direct and reflected rays being indicated by dotted lines. The reflector and conical heater are sustained by a flat hub and eight radial spokes bent upwards towards the ends at an angle of 45°. The hub and spokes are supported by a vertical pivot, by means of which the operator is enabled to follow the diurnal motion of the sun, while a horizontal axle, secured to the upper end of the pivot, and held by appropriate bearings under the hub, enables him to regulate the inclination to correspond with the altitude of the luminary. The heater is composed of rolled plate iron 0·017 inch thick, and provided with head and bottom formed of non-conducting materials. By means of a screw-plug passing through the bottom and entering the face of the hub the heater may be applied and removed in the course of five minutes, an important fact, as will be seen hereafter. It is scarcely necessary to state that the proportion of the ends of the conical heater should correspond with the perimeters of the reflector, hence the diameter of the upper end, at the intersection of the polygonal plane, should be to that of the lower end as 8 to 6, in order that every part may be acted upon by reflected rays of equal density. This condition being fulfilled, the temperature communicated will be perfectly uniform. A short tube passes through the upper head of the heater, through which a thermometer is inserted for measuring the internal temperature. The stem being somewhat less than the bore of the tube, a small opening is formed by which the necessary equilibrium of pressure will be established with the external atmosphere. It should be mentioned that the indications of the thermometer during the experiment have been remarkably prompt, the bulb being subjected to the joint influence of radiation and convection.

The foregoing particulars, it will be found, furnish all necessary data for determining with absolute precision the *diffusion* of rays acting on the central vessel of the solar pyrometer. But the determination of temperature which uninterrupted solar radiation is capable of transmitting to the polygonal reflector calls for a correct knowledge of atmospheric absorption. Besides, an accurate estimate of the loss of radiant heat attending the reflection of the rays by the mirrors is indispensable. Let us consider these points separately.

Atmospheric Absorption.—The principal object of conducting the investigation during the summer solstice has been the facilities afforded for determining atmospheric absorption, the sun's zenith distance at noon being only 17° 12′ at New York. The retardation of the sun's rays in passing through a clear atmosphere obviously depends on the depth penetrated; hence—neglecting the curvature of the atmospheric limit—the retardation will be as the secants of the zenith distances. Accordingly, an observation of the temperature produced by solar radiation at a zenith distance whose secant is *twice* that of the secant of 17° 12′, viz. 61° 28′, determines the minimum atmospheric absorption at New York. The result of observations conducted during a series of years shows that the maximum solar intensity at 17° 12′ reaches 66°·2 F., while at a zenith distance of 61° 28′ it is 52°·5 F.; hence, minimum atmospheric absorption at New York, during the summer solstice, is $66°{\cdot}2 - 52°{\cdot}5 = 13°{\cdot}7$ F., or $\frac{13{\cdot}7}{66{\cdot}2} = 0{\cdot}207$ of the sun's radiant energy where the rays enter the terrestrial atmosphere.

In order to determine the loss of energy attending the